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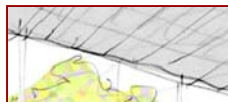
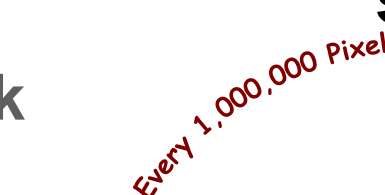
ActiveSpaces

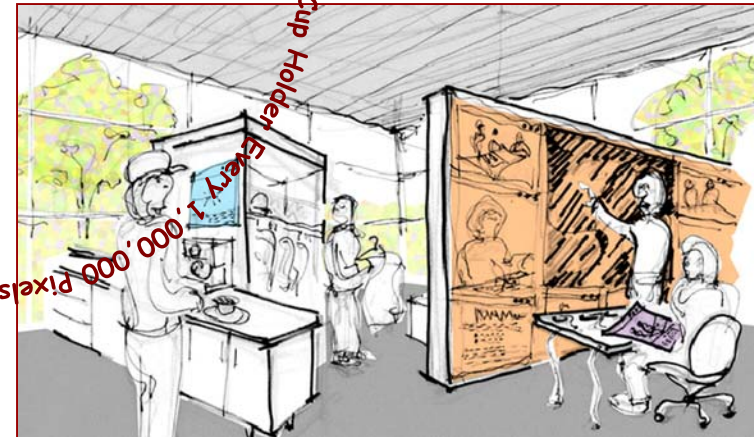
Workspaces of the Future



Roadmap

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- **Orientation**
 - Goals
 - Related work
 - Challenges
 - **Architecting ActiveSpaces**
 - Under the hood
 - Features
 - **Sensors make spaces *Active***
 - Scenarios
 - Players
 - Agents
 - Elements



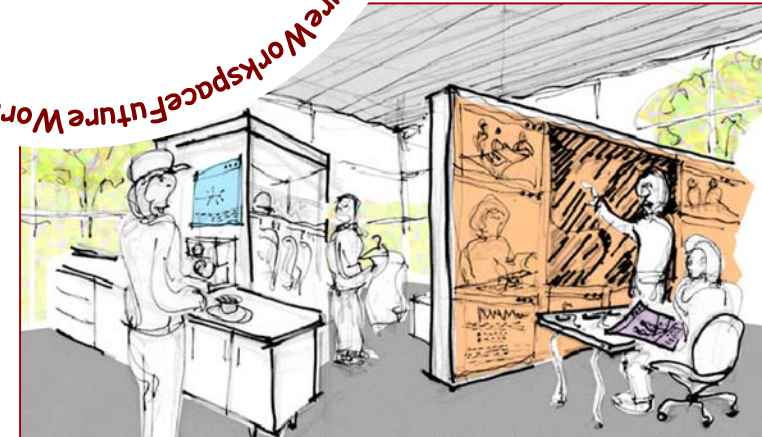
Enabling Groups & Groups of Groups

ActiveSpacesActiveSpacesActiveSpacesActiveSpacesActiveSpacesActiveSpacesActiveSpacesActiveSpacesActiveSpaces

- Visually and interactively investigate large scientific datasets
- Shared collaborative spaces must create illusion of persistent, shared resources
- Ambient connectivity – audio, video, sensors

Workspace of the Future

- **Built on existing workspace infrastructure**
- **Add high-tech IT**
- **Enhance work experience**
- **Improve productivity**
- **Responsive**
- **Not intimidating**



Related Projects

Living and Dead

- [illegible]

Challenges

- **Cross-cutting**

- Collaboration environments
- Advanced display technologies
- Advanced visualization systems
- Novel networking
- Sensor agents

- **Integration Architecture**

- Diverse components
- Seamless ad hoc inclusion
- Capability-scaled / adaptive

Why this is FUN

- **Ubiquitous computing**
 - you've got to compute to be a player in ActiveSpaces
- **Tangible UI**
 - because we interact naturally with *things*
- **Augmented reality**
 - bridging the real and the virtual
- **Agents**
 - brings responsiveness and intelligence to interactivity
- **Machine vision**
 - core technology, probably because we see our ActiveSpaces *must* see

KEY FEATURES

- **Space Design – *encourage users to congregate***
 - Comfortable, Flexible, Attractive, Compelling
- **Tightly Integrated**
 - Computing, Communications, Devices (cameras, displays, microphones, etc.)
- **Interface – *natural set of interaction modalities***
 - Hands free audio, multi-perspective video, 3D vis, direct manipulation and control

more KEY FEATURES

- **Personal Resource Integration – “*Here, I want to show you something...*”**
 - Laptop, Phones, PDAs
- **Interconnecting Collaboration and Visualization**
 - System architecture, Physical and software integration, High performance networking, Matching disparate capabilities
- **Middleware Services – *high level abstractions***
 - Multimodal communication, Security, Scheduling, Resource management

SENSORS in ActiveSpaces

- **Cues**
 - audio highlighting
 - video layout
- **Environment**
 - noise and light level
 - movement, crowded, hot, commotion
- **Interaction & control**
 - voice, gesture, virtual widgets, object manipulation
- **Monitoring**
 - “tell me when [he arrives]”
- **High level queries**
 - “Who is speaking?”
 - “Where is Mike?”
- **Dynamic identifications**
 - Speaker, audience, pizza guy
 - Where is that sound coming from? (which physical space, CD player)
- **Engage Personal Agents**
 - “...you have mail”
 - “your teragrid job started”

Attentive Spaces Notice:

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- **gesture (action)**
 - pointing, waving, blinking, nodding
- **relationship**
 - near, holding, over, under
- **attitude**
 - facing the board, leaning into, crouching, leaving, sitting, standing

A Lineup of Sensor Players

Active Spaces

- **The Usual Suspects**

- Accelerometers
- Thermometers
- Orientation sensors
- RFID
- Switches

Sensors

- **Flexible is Better**

- **Cameras**
- **Microphones**

Composites

- Digital furniture

Argonne National Laboratory
& University of Chicago
WACE 2004, Nice, France

Express Key Notions

- **space (real and virtual, local and remote)**
- **objects (real and virtual)**
- **relationships**
- **action (motion, events)**
- **physical properties**

Primitives

SENSOR AGENTS

- **Derived “meta-sensors”**

- combined: vision, audio,

- ...

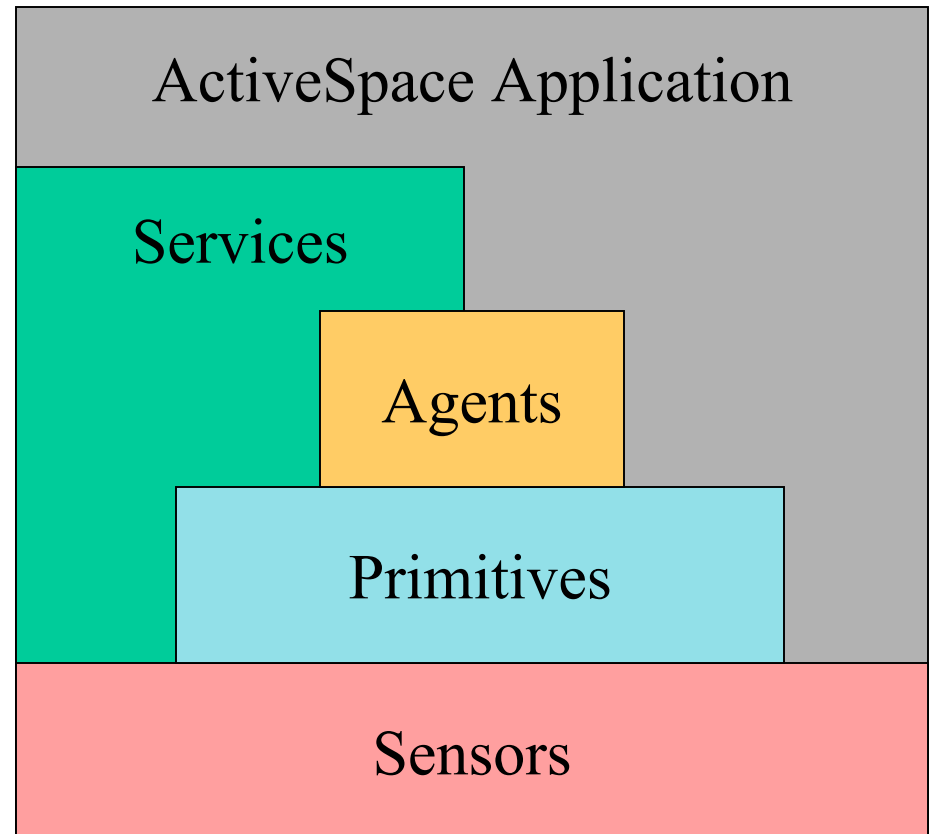
- {intra/inter}-space

- **Object tracking,
segmentation, depth**

- **Internal state**

- network quality, venue
data

Agents

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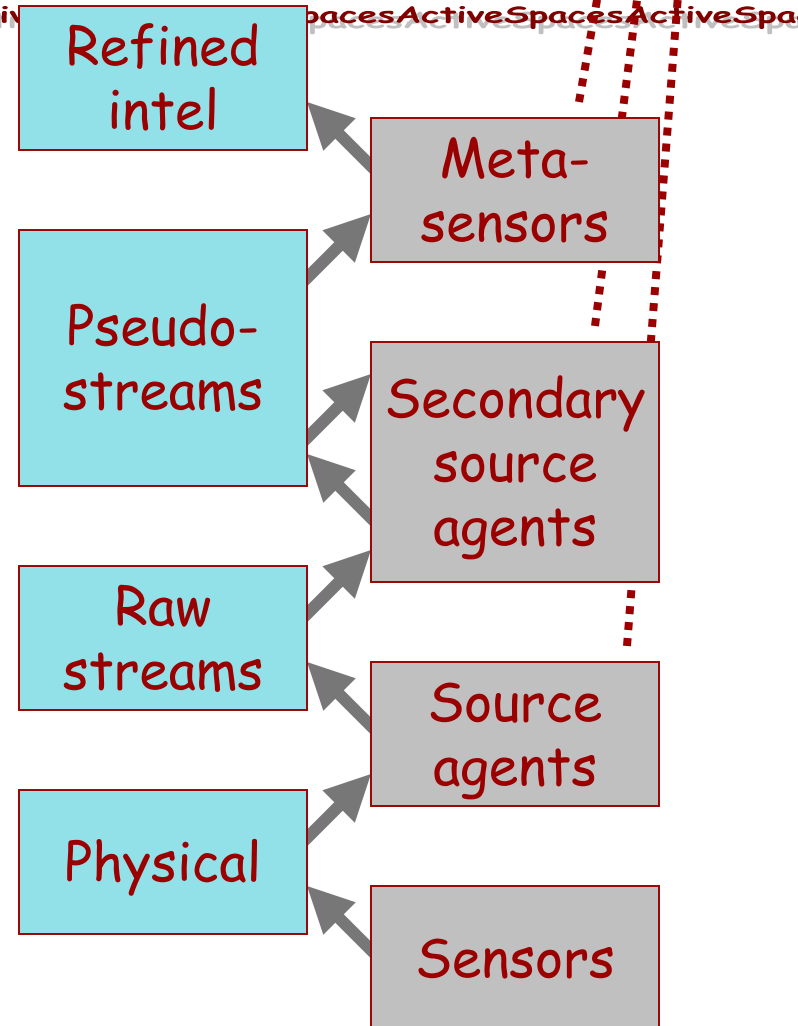
Client

- **Streams & Events**

- physical & raw
- derived
- high-level

- **Adaptive**

- Discovery
- Subscription
- Query



Sowing Active Spaces

- **Must be widely used across wide range of applications by a large community**
- **Technology must be empowering**
- **Environments must be compelling**
- **Integrated into existing modern intellectual work spaces**
- **Hale and hearty Community**



Active Spaces



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